

MICROCOMPUTER TECHNOLOGY AND INTERNATIONAL DEVELOPMENT MANAGEMENT:
AN ASSESSMENT OF PROMISES AND THREATS

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PREFACE AND ACKNOWLEDGEMENTS

In 1981 the Development Project Management Center (DPMC) of the U. S. Department of Agriculture, in cooperation with the Science and Technology Bureau of the Agency for International Development (AID), initiated a small research and development effort focusing on microcomputers and management in developing countries. This effort explored actual and potential uses of microcomputer technology for improving project and institutional management in a variety of development sectors and contexts. In 1982 a practitioner workshop was conducted to review the research results and to identify areas of high potential for future study and development. The findings of this research regarding the acquisition, installation, and use of microcomputers in developing country settings became the basis for a report entitled Acquiring and Using Microcomputers in Agricultural Development: A Manager's Guide published jointly by DPMC and the International Development Management Center (IDMC) at the University of Maryland. A revised version of this Guide was published in 1983 by Kumarian Press of Hartford, CT, under the title of Microcomputers and Development: A Manager's Guide.

IDMC is a recently established research, technical cooperation, and education Center in the Office of International Programs, Division of Agricultural and Life Sciences, at the University of Maryland. IDMC's mission involves the rigorous development and dissemination of appropriate technologies for managing agricultural programs and projects and for strengthening institutions. Among its current activities is the preparation of a case study on the use of microcomputers in development management.

This paper for the International Association of Schools and Institutes of Administration (IASIA) draws heavily on DPMC's and IDMC's ongoing research and field experience in the area of microcomputers and agricultural management. Earlier editions of this paper have been presented at conferences of the American Society for Public Administration (ASPA) and to the Interamerican Institute for Cooperation on Agriculture (IICA) conference on Microcomputers in Costa Rica in December 1983. This paper elaborates on the subject of the promises and threats of microcomputers in developing country contexts, and identifies several implications for international educational institutions in the area of administration and management.

Marcus Ingle was responsible for DPMC's research on microcomputers and management from its outset. A staff member of DPMC from 1981 to 1983, Dr. Ingle recently was named Coordinator of IDMC. Kenneth Smith has worked with IDMC since the Center's inception and directs the ongoing research on microcomputers and development management. In preparing this paper, the authors were assisted by Morris Solomon and Merlyn Kettering of DPMC and Edwin Connerley of AID. Noel Berge of Micro People Incorporated in Virginia and Fred Knight of Bertman Corporation also made significant contributions. Artie Kennedy and Amy Troup of IDMC assisted in preparing and editing the paper.

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I: INTRODUCTION: THE SETTING AND ISSUES

The world is in the throes of a microelectronic revolution. In the area of microcomputers alone, numerous types and makes of hardware components and a plethora of software programs are being purchased by the tens of thousands and are proliferating quickly to individuals and organizations in the most remote areas of the earth. A microcomputer is a small computer, composed of several pieces of equipment (the HARDWARE components), that uses various programs (the SOFTWARE) to perform numerous functions and tasks within an organizational setting (the ORGWARE* dimension). The microcomputer is a highly efficient and incredibly fast information processor capable of recording, manipulating, and storing data. Although a microcomputer is small enough to sit on top of a desk, its size belies its information processing capacity and the multiplicity of its scientific and managerial applications.

Available evidence indicates that microcomputer technology is being quickly absorbed within the international development sector (North and Berge: 1983; United Nations University: 1984). Public sector development institutions and numerous program/project units are now using microcomputers to assist with a wide range of activities. Microcomputer uses in this sector range from purely technical in scope, such as analyzing soil samples and processing survey data, to management and administrative applications such as budgeting, scheduling, report preparation, and telecommunications.

Several interrelated reasons account for the widespread appeal of microcomputers in the international development sector. First, microcomputers represent a new type of technology that appears to be unique in its "user-friendliness" and its ability to "work the way individuals and organizations do." Microcomputers possess a subtle intrigue and seductive power to well educated and conscientious public sector officials. A second reason is that initial microcomputer applications in international development, although not without difficulties, have been quite encouraging in their results. The agricultural and rural development sector, due to its major importance and wide diversity, presents a variety of ready-made opportunities for successful microcomputer use (Berge and Ingle: 1982; Pinckney et al.: 1984). Finally, interest in microcomputers has been further stimulated by low costs, small size, and a constantly expanding data processing power. In this respect, all indicators suggest that microcomputer prices and size will decline while reliability, power, and versatility will continue to increase.

* ORGWARE refers to the organizational, human, and training issues involved in microcomputer systems. This dimension is sometimes referred to as the "wetware" or "slippery" component of microcomputer technology.

The international proliferation of microcomputer technology raises a serious concern for the international administration and management profession, namely: will the proliferation of microcomputer technology facilitate productive, humanistic and equitable development administration and management processes, or will it exacerbate inefficiencies, unjust practices, and inequality? In this context two issues deserve attention:

- What does international development management experience to date indicate are the major promises and threats of microcomputer technology?
- What steps can be taken to increase the chances of the promises being fulfilled while the threats and associated negative consequences are prevented or minimized?

This paper addresses both of these issues by presenting an overview of microcomputers from a development management perspective and addressing lessons learned to date relative to promises and threats. The paper concludes with a discussion of implications for international institutes and schools of administration.

II: MICROCOMPUTERS AND INTERNATIONAL DEVELOPMENT MANAGEMENT

We view international development as a cooperative, evolving process whereby nations and their peoples are better meeting their present needs and concurrently building their capacity to meet future needs. Management, in turn, involves the economical mobilization and use of human and material resources to accomplish valued results under conditions of uncertainty and partial control. It involves a continuous cycle of planning and replanning in which managers and technical staff work together to track expenditures and progress against planned objectives, respond to unexpected changes, and incorporate lessons learned. In both planning and replanning, a continuous stream of information must be gathered, processed, and acted upon.

The management of development institutions and programs is particularly complex (Management Development Working Group: 1981). Development efforts are typically designed and implemented under harsh conditions and involve coordinated action by many individuals, units, and institutions (Paul: 1982). To achieve their intended objectives in the face of the severe resource and time constraints that often characterize development contexts, programs and projects require careful management from their inception. This care must continue through activation, operation, institutionalization, and replication, with continuous reassessment and replanning along the way. It is little wonder, therefore, that poor management is frequently cited as a major factor obstructing successful development (World Bank: 1983).

That there have been major deficiencies in the management of development efforts is readily apparent. During planning and design heavy emphasis is frequently given to economic and technical considerations. Often, the implementation requirements of development activities are underestimated or, sometimes, totally neglected. As a result, the management and technical staff responsible for implementing and replanning are frequently hard-pressed to do what is necessary to keep the effort on schedule and within budget. With the advent of microcomputer technology, development professionals have turned to the microcomputer as a tool that can play a significant role in improving and sustaining effective development management (Ingle, et al.: 1983; Pinckney, et al.: 1984; Woods: 1984; Zemke: 1984).

One way to classify and examine the use microcomputers in international development management is to begin with a list of general functions performed in successful development institutions and programs. Experience in the field of development management suggests that several generic functions--manifested in terms of specific managerial tasks--are directly associated with many successful development efforts (Management Development Working Group: 1981; Ingle: 1981; Vaill: 1982; DPMC, IICA and IDMC: 1983). These management functions include the following:

- Developing a consensus and commitment to development objectives and strategies on the part of key personnel;

- Devising and agreeing upon realistic workplans, schedules, and resources, budgets;
- Defining clear roles and responsibilities for task execution and replanning;
- Appropriately directing and controlling task execution in accordance with plans; and
- Assessing progress and responding to changes in the internal and external environment.

If these functions are carried out during a development effort, the probability is greatly increased that objectives will be achieved on time and within budget limitations.

These generic functions, and their corresponding management tasks, provide a framework for reviewing the wide range of microcomputer uses in management. While the presence of these management functions apparently facilitates successful management even in the absence of a microcomputer system, in this paper we will use these functions and their corresponding tasks to frame and present the wide range of potential and actual management uses of microcomputers in international development settings. Table 1 details various management tasks related to the generic functions and describes possible microcomputer uses and products associated with the performance of each task.

A. WHAT A MICROCOMPUTER CAN DO

The first generic management function associated with successful development efforts involves arriving at a consensus and commitment to development objectives and strategies on the part of key personnel and stakeholders. This includes developing overall policy objectives and development strategies; identifying objectives for development programs and sectoral institutions based on policies, opportunities, and targeted beneficiaries; establishing measurable performance indicators and targets for specific projects based on detailed assessments of potential benefits, feasibility, and implementation costs; and employing appropriate processes for assuring that key actors clearly understand and are committed to the objectives and strategies that have been developed.

Microcomputers can facilitate these activities by assisting in the collection and analysis of sectoral, census, and survey data; assisting with feasibility studies and analyses of project costs and benefits; and by storing and presenting output information in the form of matrices, summaries, and narrative reports. The microcomputer's ability to make easy updates and revisions allows feedback from key actors to be reentered, until all arrive at consensus on the final output.

Table 1

Genetic Management Functions, Related Management Tasks,
Typical Microcomputer Uses, and Microcomputer Products.

Generic Management Functions Associated with Successful Management of Development Projects and Institutions		Management Tasks Related to the Generic Management Functions	Typical Microcomputer Uses for Key Management Tasks	Microcomputer Products Corresponding to Various Uses
I	A consensus and commitment to development objectives and strategies by key actors and personnel.	A. Develop overall policy objectives and rural sector development strategies based on various macro and micro analyses.	<p>A1. Store, process and analyze narrative accounts of policy statements and development objectives.</p> <p>A2. Store, process and analyze agriculture and household census and survey data.</p>	<p>Ala. Narrative descriptions.</p> <p>Alb. Diagram of objectives.</p> <p>A2a. Descriptive statistics of physical, economic, social and political conditions.</p> <p>A2b. Bar charts, selected conditions over time.</p>
		B. Identify objectives for development projects and rural sector institutions based on development policies, opportunities, and identification of major beneficiaries.	<p>B1. Store, process and analyze sector and project specific problems and opportunities for improvement.</p> <p>B2. Preliminary analysis of intended target groups "paying" and "receiving" benefits from the development activity.</p> <p>B3. Initial estimates of socio-economic benefits, feasibility and costs.</p>	<p>B1a. Narrative descriptions.</p> <p>B1b. Problem tree diagram.</p> <p>B2a. Descriptive statistics of project target group.</p> <p>B2b. Stakeholder matrix of major project beneficiaries.</p> <p>B3a. Narrative list of key benefits and costs.</p> <p>B3b. Initial cost-effectiveness ratios for various project alternatives.</p>
		C. Establish measurable performance indicators and targets for development efforts based on detailed assessments of potential benefits, implementation, feasibility and costs.	C1. Store formats and specifications for targetting indicators in terms of intended performance and time.	<p>C1a. Project design matrix Narrative lists of benefits for each target group over time.</p> <p>C1b. Narrative lists of benefits for each target group over time.</p>
		D. Employ an appropriate process for assuring that key development actors clearly understand and are committed to objectives and strategies.	D1. In meetings with key policy makers and project designers, microcomputer used to take process notes and provide immediate feedback on areas of consensus and divergence.	D1a. Narrative descriptive notes of meetings and planning sessions.

Table 1 (continued)

Generic Management Functions Associated with Successful Management of Development Projects and Institutions	Management Tasks Related to the Generic Management Functions	Typical Microcomputer Uses for Key Management Tasks	Microcomputer Products Corresponding to Various Uses
II. Realistic and agreed upon workplans, schedules, and resources.	A. Develop descriptions of development activities including input and output specifications and necessary external conditions.	A1. Store formats and specifications for developing performance targets for development program inputs, outputs, and key external conditions.	A1a. Blank input/output templates.
		A2. Store, process, and organize input, output data in accordance with formatted specifications.	A2a. Completed input/output design templates.
	B. Develop work breakdown tables and create realistic personnel and resources requirements.	B1. Store and process task/work performance data associated with development efforts.	B1a. Narrative list of key activities along with prior and subsequent events.
		B2. Allocate personnel and material resources by output category, work task, and sub-activities.	B2a. Resource allocation charts and diagrams.
	C. Create a master program schedule and special subschedules for important activities.	C1. Process and analyze timing and duration of project and organizational activities.	C1a. Critical path and network schedules. C1b. Bar chart schedules.
	D. Employ an appropriate process for assuring that key managerial and technical persons understand and agree on the detailed execution arrangements.	D1. Provide a fast, reliable and convenient means whereby managers and technicians can input and obtain consensus on activity, cost, and time data.	D1a. Activity workplans jointly developed by and agreed to by key actors.
		D2. Provide readily accessible means whereby supervisors and colleagues can quickly review planning data and suggest modifications/improvements.	D2a. Workplans revised quickly and efficiently.

Table 1 (continued)

Generic Management Functions Associated with Successful Management of Development Projects and Institutions	Management Tasks Related to the Generic Management Functions	Typical Microcomputer Uses for Key Management Tasks	Microcomputer Products Corresponding to Various Uses
III. Clearly articulated and understood roles and responsibilities for executing activities and tasks.	A. Develop plans for the assignment and use of personnel, commodities, equipment, and supplies.	A1. Store, process and analyze data on characteristics of various institutions and individuals involved in and affected by the development activity.	A1a. Narrative profiles and diagrams of organizational structure and individual skills and competencies.
		A2. Store, process and analyze personnel, contracting, procurement, training, and procedural data.	A2a. Descriptive lists of key information, e.g., available contractors to perform a specific task.
	B. For each activity and sub-activity, identify responsible individual or units and assure there is a clear understanding of work and technical skills required to perform the task.	B1. Store, process and analyze current and project work loads of various units and individuals to ensure a proper balance and realistic allocation of responsibility and authority.	B1a. Descriptive and comparative statistics.
		B2. Prepare narrative and statistical plans on assignment of roles and responsibilities for executing specific tasks.	B1b. Work load projections.
		B2a. Narrative reports.	
	C. Negotiate roles and responsibilities with various personnel involved in the development effort at multiple echelons and in interrelated operational units.	C1. Store formats and specifications for negotiating and making responsibility assignments for various tasks.	C1a. Blank responsibility charts.
		C2. Provide a visual display of responsibility assignments to key actors for their reaction, modifications, and timely agreement.	C1b. Narrative instructions for negotiating roles and responsibilities.
			C2a. Negotiated/modified responsibility charts.

Table I (continued)

Generic Management Functions Associated with Successful Management of Development Projects and Institutions	Management Tasks Related to the Generic Management Functions	Typical Microcomputer Uses for Key Management Tasks	Microcomputer Products Corresponding to Various Uses
IV Contextually appropriate directive and control mechanisms for executing tasks in accordance with plans.	A. Project and control work activities according to negotiated plans.	A1. Store and maintain information on procedures and specifications for activating development efforts including staffing, contracting, training, and management.	A1a. Narrative text of procedures. A1b. Various regulations, formats and criteria for specifications.
		A2. Prepare and edit directives, memoranda of understanding, and other action documents.	A2a. Policy directives. A2b. Action memoranda.
	B. Maintain programmatic and financial records, and produce summary reports for interested government, donor agency, and contract personnel.	B1. Document and file decisions and actions.	B1a. Narrative descriptions of implementation action.
		B2. Record and maintain files on actual expenditures, program activities, and observed results.	B2a. Narrative descriptions. B2b. Cost and expenditure data. B2c. Activity data. B2d. Time use data.
		B3. Prepare summary reports of program status following standardized formats.	B3a. Narrative reports.
		C1. Provide up to date accounts of program status and supplementary analytical information useful in decision making.	C1a. Special narrative and statistical reports.
	C. Take part in development activity reviews and evaluations to assess current and projected status and recommend improvement/major modifications in design and implementation.	C2. Permit rapid forecasts and projections of personnel work loads, cash flows, inventory, and other execution actions.	C2a. Program and financial projections. C2b. Program and financial analyses.
		D1. Provide a fast and reliable means for documenting actions and results both individually and in team meetings.	D1a. Narrative accounts of rationals for and actual decisions taken.
	D. Follow a collaborative process of execution that involves responsible actors and sponsors.	D2. Store procedures for information use and dissemination.	D2a. Narrative text of procedures.

Table 1 (continued)

Generic Management Functions Associated with Successful Management of Development Projects and Institutions	Management Tasks Related to the Generic Management Functions	Typical Microcomputer Uses for Key Management Tasks	Microcomputer Products Corresponding to Various Uses
V. Suitable monitoring, evaluation and adaptive learning mechanisms for assessing progress and responding to changes and lessons learned.	A. Identify information needs, sources of data, and means for collection for all development activities and important external conditions.	A1. Create files of baseline information of programs to be monitored by cost, activity, products, objectives and key external conditions.	A1a. Baseline files by geographical area, functional category, target group, etc.
			A1b. Baseline descriptive statistics and tables.
		A2. Store and maintain formats and specifications for data collection and processing procedures and sources.	A2a. Narrative data collection procedures and guidelines.
	B. Monitor program progress, unexpected changes in external conditions and key lessons learned relative to plans and analyze/reassess plans based on this information	B1. Store planned accounts of resource use, activity, and results and compare against actual progress over time.	B1a. Periodic status reports of planned versus actual progress-text & graphics.
			B1b. Special reports on problem areas or new opportunities.
		B2. File, maintain and analyze descriptive accounts, program changes, lessons learned, and unexpected events over time.	B2a. Narrative descriptions.
			B2b. Programmatic and financial analyses.
	C. Explore implications of alternative action strategies and undertake calculations of benefits, feasibility, and costs associated with actual and potential changes.	C1. Store data for and assist in pursuing a series of "what if" scenarios associated with changes in the initial program plans.	C1a. Statistical analyses of costs and benefits associated with alternative action strategies.
	D. Employ an appropriate process for assuring that relevant actors receive and understand high quality feedback both positive and negative on a timely basis.	D1. Store and maintain formats and specifications for a programs monitoring and reporting system.	D1a. Blank formats for use in monitoring and reporting.
			D1b. Narrative description of monitoring procedures.
		D2. Provide visual displays of current status to key development program actors.	D2a. Visual displays and hard copy of planned versus actual progress.

The second management function is to develop realistic and agreed upon workplans, schedules, and resources. This involves developing descriptions of development activities, including input and output specifications and information on critical external conditions; developing work breakdown tables and determining realistic personnel and resource requirements; creating a master schedule and special sub-schedules for important activities; and employing an appropriate process for assuring that key managerial and technical persons understand and agree on the detailed plans.

A microcomputer's analytic capabilities are particularly useful in facilitating the accomplishment of these tasks. A micro can store formats and specifications for performance targets, project inputs, outputs, and key external conditions, and can process data in accordance with the formatted specifications. A micro can also assist in the development of work breakdown diagrams and rapidly process and analyze timing and duration of activities through the preparation of critical path, network, and bar chart schedules. Microcomputer technology provides a fast, reliable, and convenient means whereby managers and technicians can jointly obtain consensus on activities, and quickly review planning data to suggest modifications for improvement.

The third function is to define clearly articulated and understood roles and responsibilities for executing activities and tasks. Relevant subtasks are: the development of plans for the assignment and use of personnel, commodities, equipment, and supplies; the identification of the individual or unit responsible for each activity involved in the effort and making sure that understanding, incentives and skills are available; and negotiation of the roles and responsibilities of the various personnel involved in the effort.

Microcomputers can facilitate this process by storing, processing, and analyzing data on selected characteristics of various institutions and stakeholders involved in and affected by the development activity, as well as procedural data pertaining to personnel, contracting, procurement, and training. They can also keep track of the workload of various actors, review the balance of resource allocation between operational units, and prepare reports for the review of managerial decision makers.

The fourth management function is the appropriate direction and control of task execution. This involves controlling actual work activities according to the negotiated plans through the development and issuing of policies, procedures, rewards and sanctions. Elements are the maintenance of programmatic and personnel records, the provision of summary reports, and the conduct of periodic reviews. This permits improvements or modifications to the project design and implementation process.

While a microcomputer's capability for generating reports has already been mentioned, during task execution the microcomputer facilitates up-to-date accounts of policies, procedures, and project status, and allows for fast and reliable modeling of contingencies based upon changes in plans or resource availabilities.

The fifth function is the assessment of progress and response to changes in the light of lessons learned and changing conditions. This includes the subtasks of: identifying information needs, sources of data, and means for collecting it; monitoring the development effort's progress; exploring the implications of alternative strategies and methods; and implementing an appropriate process whereby the relevant actors and stakeholders receive and comprehend high quality feedback. Microcomputers can facilitate these actions, again by serving as the repository of program and financial information, and as the means of manipulating the information thus stored according to various models and usable formats.

B. WHAT A MICROCOMPUTER CANNOT DO

Microcomputers can be highly efficient and, given their capabilities, it is not hard to understand why they might become indispensable to development management professionals. However, simply introducing a microcomputer in a development setting and expecting it to meet many of management's needs is setting the stage for early disappointment and eventual failure. While the microcomputer can facilitate the tasks and processes listed above, there are many limitations inherent in the technology. A microcomputer:

- will not make one more organized;
- will not make decisions on one's behalf;
- will not improve one's basic data (i.e., garbage in, garbage out);
- does not accept responsibility for anything;
- does not of itself do forecasting or trend analysis (but it can help one do it);
- cannot define a problem or agree upon objectives.

The development management professional is still the most important part of the technology. No matter how fast the hardware and software can come up with data and information, it is still the manager who must decide what is to be done and how it is to be put into effect.

III. ASSESSMENT OF PROMISES AND THREATS

In Section I, two issues related to microcomputer technology proliferation were raised:

- What does international development management experience to date indicate are the major promises and threats of microcomputer technology?
- What steps can be taken to increase the chances of the promises being fulfilled while the threats and associated negative consequences are prevented or minimized?

These issues are discussed below in light of several case incidents and other recent experience. The data for this assessment comes from a review of two types of microcomputer applications: program management improvement efforts and institutional strengthening efforts (Berge & North: 1984; Ingle, et al.: 1983; Ingle & Connerley: 1984; Katterring: 1982; Mann: 1982; Pinckney: 1984; Sadowsky: 1982; Schware: 1984; and, Woods: 1984). The program management experience includes a rural development project in Tanzania, an agricultural production program in Portugal, several rural development project microcomputer applications in Nepal, and other applications. The agricultural institutional strengthening experience draws on a financial improvement effort in the Kenyan Ministry of Agriculture and Livestock, the agricultural census remote sensing activities in DC's by USDA, several experiences with agricultural organizations in the Philippines, and other applications.

A. THE PROMISE OF MICROCOMPUTERS IN DEVELOPMENT MANAGEMENT

In his opening statement to the US House of Representatives Subcommittee on Science, Research, and Technology in July 1982, Curtis Farrar of AID discussed the promising role of microcomputers in development by noting:

The most important contribution that microcomputers will make to development will be the increased accessibility they provide to substantial computational power and analytical power. They are relatively cheap. They do not require sophisticated programming training. Their computational power and versatility is increasing every year. Where the data and analytical skills exist and where there is a demand for improved analysis, they provide the potential for substantially improved analytical and planning capacity in development institutions. More importantly, the micro permits substantial decentralization of this computing power to the field (Farrar:1982).

Mr. Farrar also pointed out several additional contributions that microcomputers may make to development: increased access to information; more timely manipulation of information; the improvement of planning and problem solving situations; and finally, its ready acceptance--the ease of transfer--due to its ease of use and modular character. As Mr. Farrar

summed it up, "The microcomputer can be thought of as a disaggregated general purpose system and can provide the developing countries the flexibility of applying computer power to a wide range of development problems not possible with a large mainframe computer."

In marked contrast to the large mainframe computers, the microcomputers have several attractive attributes for development applications. They:

- are easier to comprehend and more friendly to use;
- have greater reliability and are constructed in a modular fashion that facilitates repair and maintenance;
- have substantial versatility and power in their applications including the ability to network with other microcomputers and larger computer systems that already exist;
- are fairly transportable (with little or no additional cost or trouble) domestically and internationally; and
- are relatively inexpensive (ranging from \$1,000 to \$5,000) for a complete hardware and software system.

Because of these positive attributes, microcomputers are considerably more popular than mini and mainframe computers.

To the busy and committed development professional, the microcomputer also has a strong personal appeal. Microcomputer hardware and software components have now been developed to the point where they can quickly assist in carrying out technical and administrative tasks more efficiently with improved results. While the evidence on microcomputer costs, feasibility, and benefits in developing countries is not exclusively supportive, there is substantial reason to believe that microcomputers are able to assist in the performance of tasks at the individual, unit, and organizational levels. The most obvious improvements to date are evident in handling routine, tedious, and time-consuming tasks associated with accounting, word processing, and filing. In this area, microcomputers can provide an alternative to hiring additional staff--an option that must be thoroughly considered in many public sector development situations.

The power, speed, and accuracy of this technology now makes it possible to carry out various routine support tasks in a low-cost manner. For example, personnel can use the micro to quickly prepare memos, complete workplans, and construct budgets. This frequently releases technical and administrative staff to assume additional responsibilities for actually guiding, monitoring, and reporting on development activities. Middle and top-level executive time can be freed by using the microcomputer for data manipulation, analyses, visual display preparation, document revision, file searching and merging, inventory control, personnel appraisals, and financial management. This saved time can be used productively to consider new strategic management opportunities and options (Paul: 1983).

The microcomputer is also demonstrating its usefulness as a tool for strengthening development institutions through initiating, improving, and sustaining organizational performance. The case of the Kenya Ministry of Agriculture and Livestock Development demonstrates one way that microcomputers can be usefully applied to upgrade a budgeting and financial system (Pinckney, et al.: 1984). In addition, this technology can be instrumental in improving decentralization and participation (Ingle and Connerley: 1984). The use of microcomputers may allow decentralization and participatory operations to be initiated and sustained by providing local units with a low-cost means for assuring accountability and responsible decision-making. Recent experience from Kenya, Nepal and Portugal also indicates that the microcomputer can be used to accelerate managerial learning, increase the productivity of work teams, and improve the quality of the work environment (Bertoli and Bertoli: 1981; Ingle and Connerley: 1984; Scwhare: 1984). Indeed, the initial empirical evidence suggests that, if correctly introduced and intelligently used, the microcomputer has the potential for improving development management performance across a wide variety of tasks and functions.

The promises of microcomputers in development management are greatly facilitated by the attribute of the technology referred to as "user-friendliness". User-friendliness of software and hardware facilitates the perceived and actual usefulness of microcomputers. Originally, to understand the computer one had to be fluent in a software programming language (e.g., FORTRAN) or an application language (e.g., SPSS) with its own syntax and structure. This software requirement isolated all but a handful of initiates from computer use; it still restricts accessibility to large computers. But this need not be the case with the microcomputer. Because of the user-friendliness designed into the software, people with relatively little training can tell the microcomputer to do what they want it to do. The microcomputer is programmed to speak the user's language. This change adds a unique, transparent quality to the technology, and accounts for much of its personal appeal (Gotsch: 1982). The new "integrated" software now available is permitting microcomputers to be even more user-friendly.

Of equal importance is the user-friendliness of the hardware (the central processing unit, the disk drives, the keyboard, the printer, and the monitor, etc). While care of microcomputers is still required, the antiseptic conditions needed to sustain the large mainframes are no longer necessary. Nor does a certified technician stand between the user and the equipment. The ease of interaction between and among the components and the user makes access to the system quite simple.

B. POTENTIAL THREATS OF MICROCOMPUTERS

Although the appeal of the microcomputers is obvious and rapidly expanding, there are many drawbacks to the technology's acquisition and use. The microcomputer is a powerful tool that, if some basic precautions are not taken, can be severely misused. From the perspective of international

development management, potential threats from introducing a microcomputer can be clustered in three categories: technology costs, organizational processes, and development results. The potential threats in each of these categories are discussed below.

1. Technology Costs

In general, the costs associated with microcomputers--especially compared to larger computers--are extremely low. However, when viewed in the context of development programs and institutions, over time, the costs escalate considerably. Complete microcomputer systems, including basic software programs, cost in the range of US \$3,000-5,000 each. In development contexts these initial purchase costs can easily double or triple if: (a) redundant components are purchased for backup support; (b) special equipment is included to handle electrical power fluctuations and/or (c) programs need to be custom designed for special management applications. Costs can double again if the natural desire "to keep up with technological improvements" is operating among management professionals. As new components are added, system compatibility becomes a pressing concern. Imagine the consternation of a technician discovering that s/he has to learn a new budgeting program because the current one "does not work exactly right" on the newest microcomputer model just purchased! Compatibility and maintenance costs are frequently hidden and over time can be substantial. These costs escalate in development contexts. Last, but not least, there are various organizational or orgware costs including staff time for learning, needed attention to new policies, and various revisions in procedures and routines (Ingle et al.: 1983). Orgware costs are estimated to be at least double the combined costs of hardware and software.

2. Organizational Process

The threats in the area of organizational process are also several, and potentially quite severe. First, there is the possibility that microcomputers will give staff the false impression that "objective data" and "formal lines of communication" need to be emphasized to the exclusion or neglect of subjective and informal information. Caught up in the "hype" that surrounds micros as the technology of the future, managers and technicians can be insidiously distracted from the inherently human nature of successful development efforts. Furthermore, the push for doing everything--communications, reports, accounts--with the microcomputer might drive out other essential organizational tasks, such as strategic planning, networking, and learning by doing, that do not lend themselves readily to quantification and automation. A related problem is "blind faith" in microcomputer generated output where adequate and valid input data has not been procured. Microcomputers do not automatically address the issues related to providing adequate Management Information. Finally, while microcomputers offer the promise for more decentralization and delegation of responsibility around specific organizational tasks, they also bring the threat of narrow specialization and concentration of information processing power. This final threat is extremely pronounced

in Third World countries where administrative power is already highly concentrated, and those holding public office are well positioned to benefit first and most from microcomputer technology.

3. Development Results

In the category of development results, the potential negative effects associated with microcomputers are more diffuse and uncertain. First, while microcomputers may help an organization increase its internal productivity, there is no reason to equate this with "doing what is needed developmentally!" Issues of effectiveness must be addressed, and it is uncertain whether proponents of the microcomputer revolution are adequately doing so (Servan-Schreiber and Negroponte: 1982; Shirkle and Fleuer: 1981). Second, there is a grave concern on many fronts for the labor displacement that may be associated with the microelectronic revolution, especially in Third World Countries. Leaders of the World Microcomputer Center in Paris estimate that microelectronic technology will cause displacement of millions of jobs in developing countries before the end of the century. Finally, and possibly most important, given current trends, the threat exists that this new technology will further exacerbate development inequalities both between and within nations.

C. ANALYZING THE ISSUES: SOME LESSONS LEARNED

The first issue deals with apparent benefits and burdens associated with the introduction and management use of microcomputer technology in international development settings. Several lessons are now evident in regard to this issue. Evidence suggests that the introduction of microcomputers is accelerating in public sector management settings around the world. There is also substantial reason to believe that the international proliferation of this technology will continue due to breakthroughs in user-friendliness coupled with increasing versatility and decreasing costs. A second lesson is that the introduction of microcomputer technology is a mixed blessing--there is ample evidence of substantial benefit and burden.

The second issue is more prescriptive. It seeks to determine what can be done to increase microcomputer benefits while preventing or minimizing the threats associated with the technology. In this regard the first lesson that has emerged from experience is that the benefits associated with microcomputers are most pronounced when the technology is appropriately introduced, intelligently used and sustained.

Based on our assessment, the appropriateness of a microcomputer system rests first and foremost on the actual needs a system can meet, and secondly on the degree to which a system's use can be effectively sustained. By actual needs we refer to those current or potential management tasks in the development program or institutional context that can be met through the use of a microcomputer. The potential for system sustainability is a function of various environmental conditions, combined with evident, relevant, and cost-effective performance.

A flow model of the variables involved in microcomputer introduction, use, and institutionalization is presented in Figure 1. This figure depicts the microcomputer transfer sequence over time, and sets out the importance of various factors in the short, medium, and long term. The chart is read from left to right, each column representing a phase of system sustainability. For example, if a needs assessment (Column I) is favorable towards acquiring a microcomputer, the factors listed under Column II are necessary to have minimum system use in the short term. Continue reading to see the minimum set of factors associated with system use and institutionalization over time, and when one should deal with them. For example, the dirty power (Factor #1) issue is something that one should take care of immediately. The need for documentation written in the local language (Factor #4) is not of equal priority, but it should be considered in the long run. Thus, viewed as a process, the factors presented in Figure 1 determine the sustainability of the microcomputer as a viable development management tool.

A second lesson, therefore, is that the decision to introduce microcomputer technology hinges upon several inseparable factors, but, at least initially, the critical factor is the presence of tasks that need doing, and that can be directly facilitated by a microcomputer. Once one determines that a computer can actually help, then organizational and environmental factors become paramount. A list of some practical "do's and don'ts" for introducing microcomputers into development settings is found in Table 2.

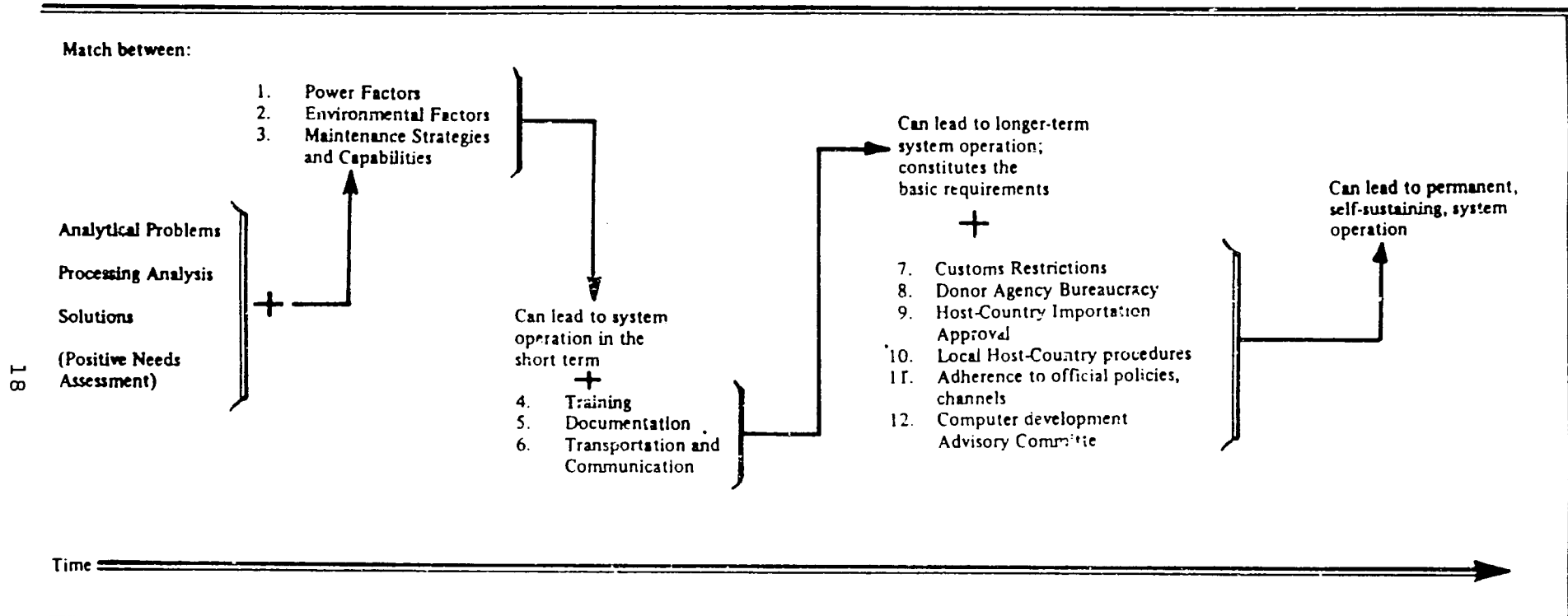
A third lesson emerging from initial field experience is potentially very significant for the international management profession. Based on the Kenya and Portugal cases, microcomputer technology has been instrumental in leveraging major management system improvements (ie., in performance budgeting) and in providing a low cost, readily usable tool for supporting the new systems once introduced. As stated in the Portugal case study,

For microcomputers, optimal (rather than maximum) applications to directly productive organisational tasks should be sought in any given transfer attempt. This technology is cost-effective at surprisingly low levels of use.... In the PROCALFER case, the management improvements resulting from the PIMS technology generated productive organisational tasks suitable for microcomputer use. (Ingle & Connerley: 1984)

This suggests that microcomputer technology might be used in conjunction with other "system redesign" applications to facilitate initial entry and provide the required information processing capacity upon which use and institutionalization depend. Ongoing research supported by the S&T Bureau of AID is now explaining these and other microcomputer and development management issues in more depth.

Figure 1:

Ordering the Technical Factors Involved in Institutionalization
of the use of Microcomputers



The Figure above was based on the list of critical issues involved in institutionalization generated by the participants at the Michigan State University conference on Microcomputers, May 1982, Working Group Two. The list that emerged was:

1. Needs Assessment
2. Power needs considerations
3. Environmental considerations
4. Maintenance strategies/capabilities

5. Software documentation (and in local language)
6. Training considerations
7. Transportation and communications
8. Customs restrictions
9. Donor agency bureaucracy
10. HC importation approval
11. Local host country procedures, regulations, etc.
12. Adherence to official policies/channels
13. Computer Development Advisory Committee

TABLE 2

**Do's and Don'ts of
Acquisition, Installation, and Use of Microcomputers**

Planning

1. Determine what you need a microcomputer to do for you. Then choose the software before you choose the hardware.
2. When considering the hardware, find out what others in your area are using and seriously consider purchasing that kind of equipment.
3. Have a plan for cleaning up the power supply.
4. Have a plan for training.

Purchasing

1. Explore your options. Talk to different dealers and have them show you how to set up the system and how to use it. Work with a friend or colleague.
2. Order all miscellaneous materials and supplies you need for one project year, especially extra documentation.
3. Purchase connector cables when you order the system.
4. When you first buy equipment, also buy the tools, spare parts, test equipment, and hardware manuals (with schematics).

Installation

1. Spend time with someone who has a similar system and learn how to put it together.
2. If possible, get assistance from someone who knows how to install the system.
3. Set up the whole system before plugging it in to the power supply. Plug in another piece of equipment (e.g., a lamp) into the outlet you intend to use for the system.

Table 2 (continued)

Power

1. Provide electrical protection:
 - based on local network experience or knowledge; and
 - in the light of budget needs.
2. Consider the use of an Uninterrupted Power Supply (UPS).
3. Provide a non-fluctuating source of power to the equipment.
4. Dedicate a single line to your equipment, one that is pre-conditioned.
5. Provide common "earth" ground between all system components.
6. Condition your power appropriately.
7. Power on/off switches can fail. Consider unplugging your system when you turn it off instead of using a switch.

Hardware

1. If possible, consider buying one extra system for use during system breakdown or for possible spare parts.
2. Consider buying a diagnostic testing board for troubleshooting. (The Apple IIe has one already built in.)
3. In a central unit with built-in monitor and keyboard, you lose some maintenance flexibility. If you have to send an item away for repair, it is often convenient to send only the sub-unit needing repair instead of the entire unit.
4. 48K of memory is adequate for running the packaged software most used in development projects. For most systems, when and if you need more memory, you can buy a "chip" or another "board" that contains additional memory.
5. For the average development project, the size of the data base can be fairly easily determined and the size of disk drives properly selected. Disk drive size is not a major variable in system selection--only if you are using a program that requires 8 inch disk drives, or if you have a large data base, would you consider large disk drives or hard disks.

Software

1. If it is not built into the system, and if possible, buy a diagnostic software package to test your system problems.

Table 2 (continued)

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2. Buy interactive software packages.
 3. Buy "how to" packages and use them as well as the tutorials to learn how to use particular kinds of software.
 4. Buy only the software packages you need.
 5. Learn one or two software packages at a time.
 6. If your work involves a substantial amount of writing, give serious thought to getting a word processing program.
 7. Games programs are good for training and for breaking down some of the initial resistance frequently encountered in development project situations.

Diskettes

1. Keep diskettes in their jackets.
2. Have extra blank, formatted diskettes available.
3. Make backup copies of all diskettes--update and copy as necessary.
4. Keep a card catalogue of files that appear on each diskette, or some other form of external retrieval system (e.g., print outs of disk directories that are dated and kept in file folders).
5. Use only felt tip pens to write on diskette labels--pressure on diskettes from ball point pens may damage them.
6. Keep your diskettes and records with you if you and others share the equipment.
7. Keep archive copies of diskettes in another location for safeguarding.
8. Copy diskettes over a year old.

Maintenance

1. Whenever the system is opened for modification or routine maintenance, it should be turned off and unplugged.
2. Take off all jewelry and touch metal before going inside the "turned off" system.
3. Do regular monthly maintenance.

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4. When someone else is doing maintenance, watch and take notes on exactly what s/he is doing.
 5. Inform yourself about computer maintenance by reading articles, equipment manuals, etc., and learn to diagnose problems.
 6. Keep a maintenance notebook.
 7. Know the different tolerance levels (concerning power and frequency requirements) for each piece of hardware, e.g.:
 - electrical power 220, plus or minus 5% to remain operational; and
 - 50 CPS (frequency), plus or minus 5% to remain operational.
 8. The microcomputer industry is rapidly establishing sales and service facilities in developing countries which will eliminate the need for individuals and projects to provide their own maintenance capability.

Environment

1. Do not eat, drink or smoke near equipment.
2. Protect equipment from food, drink, tobacco smoke or any foreign matter by keeping it covered with a lint free cloth when not in use.
3. Keep equipment cool.
4. If the equipment is in an air conditioned room, seal all windows shut, have a backup air conditioner available, have a spring on the door to keep it closed, use a wet bulb humidity measure and, if necessary, a dehumidifier in the room or inside the computer itself.
5. Keep the computer away from the air conditioner.
6. Provide an environment without static electricity--rubber mats under the machine, static free carpeting.
7. Provide adequate ventilation, e.g., fan blowing on computer or in room.

Supplies

1. Stock all fuses (of proper amperage) for all equipment.
2. Stock all needed supplies including diskettes, ribbons, cables, print heads, paper transformers, etc., for a minimum of one year to the maximum life of the project.
3. Stock chips and boards as part of your spares kit.

IV. IMPLICATIONS FOR INTERNATIONAL SCHOOLS AND INSTITUTES OF ADMINISTRATION

Several common themes emerge from our assessment. One is that microcomputer technology, and microelectronics more generally, will likely have a profound impact on public sector information processing structure and functions in the coming years. Public sector administrators and managers in all parts of the world will confront and need to come to terms with microcomputers and other "high tech" innovations. A second theme is that "high tech" appears to be a mixed blessing which brings with it substantial promise combined with many potentially serious threats. In this sense taking a passive stance toward the technology is no assurance that beneficial results will occur. Rather, in the microcomputer area a proactive stance is required--one that assures the proper acquisition and introduction of the technology given contextual priorities, needs and other conditions.

These themes naturally lead to several implications for international schools and institutes of administration. The implications are presented in three areas where such schools and institutes typically function: education/teaching/training; technical cooperation/assistance/consulting; and research/development/dissemination.

A. EDUCATION/TEACHING/TRAINING

- If your school or institute is not yet involved in microcomputer technology education, take your first step now, invest in a system and learn by doing

The public sector demand for education and training in microcomputer based information processing can be expected to expand substantially in the coming years. The time to get involved with microcomputers is now. Schools should not assume that their computing departments and data processing divisions are the most likely homes for microcomputer technology. Experience in the U.S. and other countries suggests that microcomputers can be readily and cost effectively supported at the individual faculty or department level. In fact there is evidence that the truly unique characteristics of microcomputers for managers and administrators cannot be easily appreciated and understood by professionals with a mainframe computer orientation. Some of the most creative educational work with microcomputers is being done by individuals with a user focus who have had little previous computer or information systems training.

- Choose a new generation microcomputer system suitable to your school's conditions and likely management applications.

Prior to selecting a microcomputer system undertake a systematic, yet fairly rapid needs assessment. A needs assessment methodology for international contexts is presented in Ingle, et al., 1983. Give high

priority to assuring that the system(s) is powerful enough to support an integrated software package (i.e., spread sheets, word processing, data base management, etc.) and is locally servicable.

- In addition to offering specialized administrative courses which rely on microcomputers as an analytical tool, consider an overview course on microcomputers and administration/management.

One way to quickly learn about and keep up with this rapidly expanding field is to develop and conduct an overview course. There are enough books and case studies, supplemented by many articles, now emerging to make such a course both feasible and potentially very rewarding for faculty and students. Such a course could also be used as a laboratory for identifying high priority local needs that could be followed up with special training programs or other educational activities.

B. TECHNICAL COOPERATION/ASSISTANCE/CONSULTING

- In advising public sector programs and institutions on the acquisition and management uses of microcomputer technology, insist on a needs assessment and emphasize the range of benefits and burdens associated with the technology

Many public sector officials' main form of contact with microcomputers to date is through private sector promotion. In the management/administration area, officials need factual information on the likely costs and benefits associated with this new technology. Managers also need to gain an appreciation for the high state of flux currently associated with this technology. The distribution of books and case studies on management applications can help serve this purpose.

- As an initial microcomputer and management application, schools and institutions of administration might like to consider their own departments or units as potential learning laboratories.

The final payoff for this technology is in its productive use. It is difficult to assist public sector officials with management applications if your institute has no experience base. One way to gain that experience is to start using microcomputer(s) for management/administrative applications on a part time basis. Following this tack will also allow you to identify faculty and students with interest and skills in both microcomputers and organizational process consultation.

- Encourage faculty and students with access to microcomputer systems to become involved in local microcomputer networks.

An interesting feature of microcomputers in many countries is the networks that spontaneously arise between users of similar brands of systems. These largely informal networks serve as valuable mechanisms for learning, hardware and software support, and the generation of education and technical assistance opportunities.

C. RESEARCH/DEVELOPMENT/DISSEMINATION

- Studies should be initiated to review the potential benefits and burdens of microcomputers for potential client groups given local conditions.

We still do not know very much about the types of management applications of microcomputers that are most appropriate in what situations, and how they should be locally configured and adapted. Research studies are required to determine this in the context of local needs. Based on this, strategic and operational guidelines can be developed that will maximize benefits and induce sustained and equitable development processes.

- Schools and institutes should develop the internal capacity to keep current with new microcomputer technology breakthroughs.

International institutions need to stay abreast of new developments so that accurate reassessments of local implications can be quickly completed. This would require at minimum the subscription to several periodicals and journals. Costs for this activity could be substantially reduced if combined with education/training or technical assistance/consulting operations.

In conclusion, microcomputer technology provides some of the means to address the needs of improved public sector management. The technology facilitates the provision of user-oriented, low-cost and timely information. Microcomputers are allowing decisions to be made in days rather than months. In some settings professionals with access to microcomputers believe that they have gained more control over their actual work situations by being able to quickly identify alternatives, analyze them by asking a series of "what if?" questions, and gaining an understanding of the implications of particular decisions. However, fear and skepticism on the part of potential users are frequently encountered in organizational settings, so one must be prepared to face these attitudes and seek ways of overcoming them. Finally, there is as yet no articulated theory or understanding of how microcomputer technology can be employed to improve the performance of international development programs and institutions. The whole process is technologically unique, and dynamic. Microcomputers bring with them the promise for improving our means of managing, and our views of management. But they also bring some serious threats. Those who intend to invest in microcomputer technology need to give careful attention to assuring that the expected benefits of microcomputer acquisition and use outweigh their negative consequences.

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